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MEMORANDUM REPORT NO. 1485

JUNE 1963

PREPARATION OF POROUS NITROCELLULOSE FOR A TRAVELING CHARGE GUN

James E. Cole
Carl R. Ruth

RDT & E Project No. 1M010501A004

BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

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B A L L I S T I C   R E S E A R C H   L A B O R A T O R I E S

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JCole/CRuth/mec
Aberdeen Proving Ground, Md.
June 1963

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ABSTRACT

A method is described for the preparation of porous nitrocellulose propellant with a density-gradient of 0.9 gm/cc at one end to 1.2 gm/cc at the other end. Hardware refinements are discussed for the loading and pressing of the nitrocellulose. A table is included showing the variation of density with different compressional forces. A description is given of the assembling of the hardware and inhibiting the propellant.

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INTRODUCTION

Various porous propellants for use in a traveling charge gun have been investigated by the Ballistic Research Laboratories.[1,2,3] Recently Cole and Adams described a process[4] for the preparation of porous propellants in the density range 0.8 to 1.3 g/cc. Their objective was to produce porous propellants having a narrow density gradient over the length of the round. Since then a porous nitrocellulose propellant has been formed for traveling charge rounds with a wide density gradient. These rounds have a length of four inches, an outer diameter of 0.575", and a density variation of $0.9 \pm .05$ g/cc at the one end to $1.2 \pm .05$ g/cc at the other end. For firing as a traveling charge, an inhibitor coating is applied to the porous propellant.

PROPELLANT PREPARATION

The procedures used to prepare the propellant (Military Grade Nitrocellulose 13.15N) were essentially the same as described in an earlier BRL Report.[4] The significant differences in the preparation procedure were the loading and pressing of the nitrocellulose into the mold. The loading of the material into the mold was achieved with the aid of a specially constructed eight-inch riser fitted to the top of a six inch mold (Fig. 1). This riser enabled the nitrocellulose to be added in one large unit instead of in several increments. A torque wrench on the arbor press enabled the operator to apply and repeat any specific compressive force when preparing the propellant. A constant load was applied to a consolidating ram during curing in order to achieve the density-gradient required in the round (Fig. 2).

TRAVELING CHARGE PREPARATION

After the propellant was prepared it was glued to an aluminum projectile and inhibited to form a traveling charge projectile (projectile, propellant and inhibitor). The inhibitors examined were an organosol of a double base propellant (M-8); a liquid plastic; and an aluminum sleeve.

The initial step in inhibiting a traveling charge with the M-8 or liquid plastic was the fastening of an aluminum projectile to the propellant. Next a dip coating of a solvent solution of M-8 was used to inhibit the propellant. The M-8 inhibited round was then cured by partial room temperature evaporation of the solvent and a final cure for ten hours in a 40°C oven.

A potting process was used for propellant inhibited with liquid plastic. After potting the propellant into molds containing the liquid plastic, the assembly was placed in a 25°C oven to cure the liquid plastic by polymerization. The sample cured in two hours.

The pre-fabricated aluminum sleeve inhibitors had the correct outside diameter. It was, therefore, necessary only to use a solvent solution of M-8 and pot the porous propellant into these aluminum sleeves.

DISCUSSION

Initial studies indicated that the density-gradient, and especially the density of the top and bottom one-inch pieces of a round, was due to the compressional forces applied during both packing and curing. The table illustrates this effect on the density-gradient for a propellant round. When increment loading was used the density-gradient changed irregularly at the increment junctions. Elimination of weak, irregular density connections between successive increment pressings[4] has been attained by using an eight-inch riser which enables the nitrocellulose to be added in one increment.

The propellant, used for the aluminum inhibited or plastic inhibited traveling charges, was 0.575 inches in diameter before it was inhibited and 0.625 inches after the inhibitor was applied. To use M-8 to inhibit rounds, it was necessary to start with 0.600 inch diameter propellant in order to obtain the required 0.625 inch diameter end product. Figure 4 illustrates the problem encountered when additional M-8 coatings were applied to previously dried coatings. A maximum of 0.025 inch thickness of M-8 inhibitor could be applied to the outside of the traveling charge projectile because of a softening effect of successive coatings of the M-8 inhibitor on the previously dried coatings. The liquid plastic (Fig. 3) fulfilled all requirements for a coating, except for the undesirable residue left in the gun after firing. It was superior to the M-8 coating because of its ease of handling, ease of application, and fast curing to a hard translucent solid. The pre-fabricated aluminum sleeve inhibitors were used as potting containers for the porous propellant.

The performance of the porous propellant and the inhibitors tested will be published as part of a report on the traveling charge gun.

EFFECT OF COMPRESSION AND CURE WEIGHT ON THE DENSITY-GRADIENT IN A FOUR-INCH PIECE OF POROUS NITROCELLULOSE

Compression lbs/in^2	Curing Weight lbs	Density g/cc for adjacent one inch sections			
		1 (bottom)	2	3	4 (top)
86	10	0.58	0.77	0.93	0.99
86	10	0.65	0.74	0.96	1.10
160	20	0.59	0.86	1.13	1.25
224	30	0.95	1.17	1.22	1.33
224	10	0.89	1.21	1.22	1.21
196	10	0.87	1.19	1.27	1.27
196	10	0.89	1.17	1.19	1.26
196	15	0.92	1.13	1.18	1.20
196	15	0.85	1.11	1.17	1.23

CONCLUSIONS

Porous nitrocellulose propellant was formed into pieces 4" x 0.575" with a density variation of 0.9 gm/cc at one end to 1.2 g/cc at the other end. Increment loading, resulting in poor segment bonds was avoided by using a long loading riser on the mold. Techniques were developed to apply effective inhibitors to traveling charge propellant.

ACKNOWLEDGEMENTS

The authors wish to thank Mr. Horace Smith for his evaluation of the porous propellant and traveling charge rounds; Mr. Ernest Adams for designing the hardware; and Mr. Paul Brown for assisting in the preparation of the propellant.

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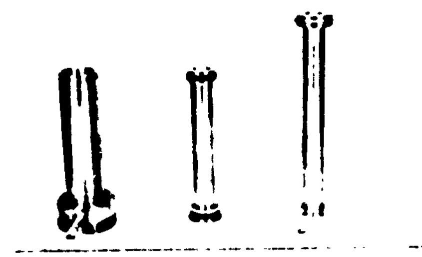

Figure 1. Mold assembly with compacting ram.

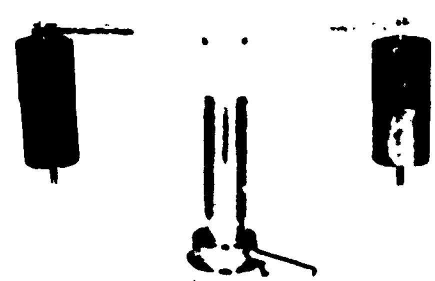

Figure 2. Mold assembly ready for curing.

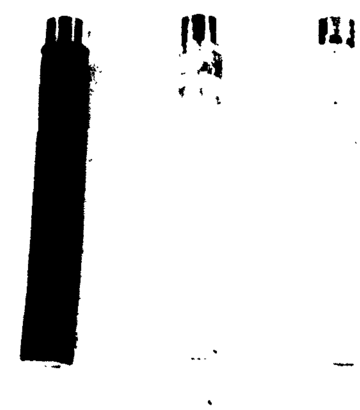

Figure 3. One M-8 and two liquid plastic inhibited traveling-charge rounds

Figure 4. Effect of excess M-8 coatings

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RDT & E Project No. 1M010501A004
UNCLASSIFIED Report

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Propellants - Preparation
Nitrocellulose - Processing

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